Forest Service

Forestry Research West

April 1998

A report for land managers on recent developments in forestry research at the three western Experiment Stations of the Forest Service, U.S. Department of Agriculture.

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In This Issue

Cover

Steve Schumacher, Custer National Forest, looks at a western prairie fringed orchid growing on the Sheyenne National Grassland in North Dakota. The plant is found in the wet lowlands of the Northern Great Plains and is listed as a threatened species. Scientists with the Rocky Mountain Research Station are working with resource specialists and other researchers to better understand how fire can be used as a tool to help manage the various plants and ecosystems of this region. Details begin on page 28.

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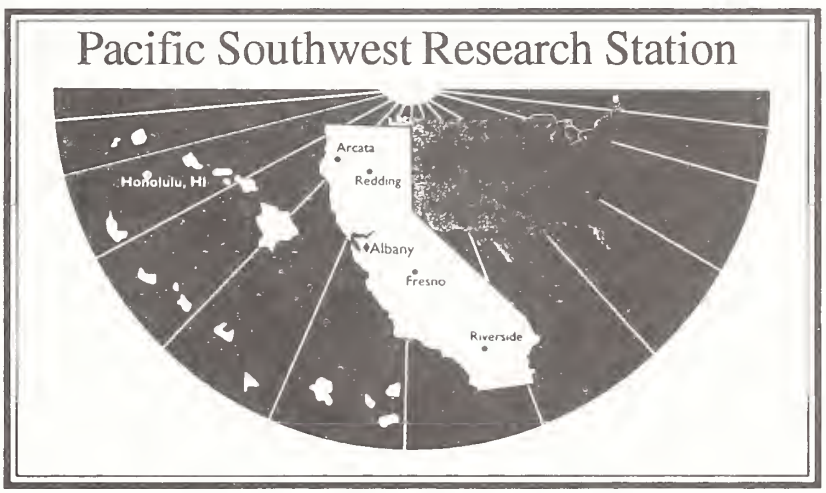
Research Brings Natural Resource Science to Life

by Connie Gill and
Joanne Hildreth,
Pacific Southwest Station

Nowhere is the competition for land use higher or more controversial than in the Pacific Southwest region. Public awareness of environmental issues is higher here than in any other region of the United States and per capita consumption of forest products is the highest in the world. Natural ecosystems and human populations are more diverse here than anywhere else in the world.

The specific goal of the Pacific Southwest Research Station (PSW) is to understand the relationships of the many components of forest ecosystems and to further understand the influences of current or proposed land production, long-term productivity, and ecosystem sustainability.

"We simply must have science informing our choices, which are ultimately driven by our needs, values, financial capabilities, and aspirations," says Hal Salwasser, Director of the Pacific Southwest Research Station. "Science has responded to this demand by providing basic data, knowledge of how things work and are related to one another, information syntheses, decision support systems, analyses of the potential consequences of options, and new technologies. The future will see more demand for these science products. And we are among the people who will supply that need."



For more than 70 years, the Pacific Southwest Research Station has been developing and delivering science-based information and technologies to help people make informed decisions about natural resources conservation and management. The Station's research results are used by National Forest managers, the Forest Service's State and Private Forestry staff, State Foresters, extension agents, other domestic and international resource managers, academia, and private landowners and partners.

PSW's long-term, interdisciplinary research centers on problems in natural resources stewardship, focusing on field application to sustain healthy conditions of wildland ecosystems for multiple benefits to current and future generations of people.

The Station's research is conducted in the conifer forests, arid chaparral and woodlands of California, and in the tropical forests of the Pacific Islands. Some of the most desirable living conditions in the world are within these zones, which has resulted in rapid population growth of this region and great demands on its resources. Society is struggling to meet these demands through the integration of ecological, social and economic values in its natural resource management decisions. The unprecedented complexity in resolving these issues emphasizes the need for the Station's research.

The Pacific Southwest research Station, headquartered in Albany, California, is responsible for Forest Service research in California and the western Pacific. Research is conducted through 14 Research Work Units: thirteen in California, located at forest science laboratories in Albany, Arcata, Davis, Fresno, Placerville, Redding, and Riverside; and one in Hawaii.

Institute of Forest Genetics

This unit is headquartered at Albany, California, with scientists located at the University of California, Davis and with a principal field and laboratory facility near Placerville, California. Its mission is to identify, describe, and understand genetic functions of forest plants, and to use this knowledge to increase the yield of western forest trees, and to conserve biodiversity and genetic resources. The unit's molecular-level research component identifies and maps the specific genes of forest plants and seeks information to describe the roles these genes play in regulating plant growth, regeneration, defense mechanisms, and other functions. Understanding these functions and their genetic controls is considered of grave importance to forest production efforts. The results of this research are applicable to private and public lands throughout the United States.

The Institute also serves as a home for research to support the ecological conservation of genetic plant and animal species. Scientists working through the Institute develop methods to inventory, monitor, and apply understanding of plant and animal genetics to conserve and restore critical diversity to these populations.

Research Values Added:

- Improved management of forest genetic resources for conservation and commodity production.

- Improved quality and performance of important western North American tree species.

- Improved conservation principles and practices for key Pacific Southwestern forest genetic resources.

- New concepts, practices, and molecular tools for improving rust resistance in western white pines.

Western Center for Chemical Ecology and Management of Forest Insects

Located in Albany, Calif., scientists in this unit investigate the ecological roles of insects in Western forests. They apply their understanding of insect behavior to develop strategies to reduce negative effects, or enhance beneficial influences, through insect- or forest-management treatments. Primary emphasis is on use of natural, insect-produced compounds to manipulate pine bark beetles, and on understanding the roles and mechanisms of insects in decomposing and recycling organic material in the forest—a critical component of long-term site productive capacity.

Research Values Added:

• Information on the roles and impacts of insects in forest and wildland ecosystems in maintaining healthy, productive forest environments.

Bark beetle tree kill.

• Increased knowledge on the taxonomy, behavior, and life histories of insects in forest and wildland ecosystems for development of safe and effective pest management strategies.

• Information on methods to detect, monitor, and manipulate insect populations in forest and wildland ecosystems.

Pacific Northwest Forest Plan

This unit provides scientific input to planning, coordinating, and supporting the President's "Plan for Ecosystem Management in Northern California, Oregon, and Washington." Station scientists provide technical assistance and support to land managers; develop new techniques and methods needed for scientifically sound implementation of the Plan and monitoring of components by resource managers; and expand scientific understanding that is needed to implement a longer-term vision of ecosystem management within the Pacific Northwest.

Research Values Added:

• Technical assistance and support to land managers.

• New techniques and methods needed for scientifically sound implementation of the Northwest forest Plan by resource managers.

• Increased scientific understanding that is needed to implement a longer-term vision of ecosystem management within the Pacific Northwest.

Redwood Sciences Laboratory for Wildlife, Forest Management and Watersheds

Located in Arcata, California, this unit is investigating timber management/wildlife interactions and management effects on hillslope processes, fisheries, and stream environments.

Timber Management/ Wildlife Interactions unit addresses questions of habitat, monitoring strategies, and forest management interactions for critical wildlife species in the Pacific Northwest. Current examples include the Northern and California Spotted owls, Marbled Murrelets, Pine Marten, Pacific Fisher, Pacific salmon, and other upland and riparian species associated with mature and old-growth forests. Close partnerships exist with a broad range of state and federal resource agencies, private land managers, and academic scientists. This has resulted in substantial savings in costs of doing research and producing results available to the public. In addition, the unit plays a key role in implementation of the President's Plan for the Pacific Northwest.

Research Values Added:

• Information on the ecological community and habitat requirements of wildlife species.

• Forest management prescriptions to assure the maintenance of viable populations of wildlife.

• Monitoring and analytical methods have been developed and implemented making cost-effective monitoring possible for a range of vertebrates, including reptiles and amphibians, neotropical migratory birds, various endangered and threatened species, and old-growth and riparian obligates.

Management Effects on Hillslope Processes, Fisheries, and Stream Environments unit scientists are working to understand the influences of land management on aquatic ecosystems at the scale of river basins, watersheds, and individual sites. Studies of the physical and biological factors

influencing land stability, sediment routing, channel morphology, aquatic habitat usage, and genetics provide information critical for managing aquatic ecosystems, and, in particular, for restoring habitats used by Pacific salmon. Research results are critical to restoration activities currently underway in California and the Pacific Northwest. Close working relationships have been developed with federal, state, private resource, regulatory agencies, and academic institutions. This unit also manages the Interagency Watershed Analysis Center located in McKinleyville, California. Scientists at the lab are developing and refining new approaches for identifying the effects of forest land management activities on aquatic habitat and for designing management actions that can best contribute to sustaining or restoring fish populations.

Research Values Added:

• Improved ways to evaluate the risk of landslides and erosion and the timing and routing of sediment in relation to cumulative effects on anadromous and resident fish habitat.

• Habitat enhancement and restoration programs, and better information on the effects of stream structure and processes and stream biology on anadromous and resident fish habitat.

Western Center for Urban and Community Forest Research and Applications

Located at the University of California at Davis, this lab's scientists conduct research that protects and improves the ecological functioning and human benefits of forests in urban and urbanizing regions, including ways to use trees to reduce energy costs for urban dwellers. Recent redirection has been to decrease emphasis on urban forestry research and increase emphasis on the effects of urbanization on forest ecosystems.

Research Values Added:

• Provide guidelines for maintaining forestry components in urbanizing ecosystems.

• Increase awareness of locating urban trees to maximize energy savings.

• Estimate the benefits and costs of urban forests.

Sierra Nevada Forest Sciences Laboratory for Wildlife, Aquatics and Ecosystem Sustainability

Sierra Nevada Kings River research project

Scientists located at Fresno, Calif. are researching Montane Ecosystems in the Sierra Nevada Mountains to identify and describe linkages between various biological, physical, and human components of forest ecosystems and evaluate forest management strategies aimed at sustaining plant, animal and fish communities in the Sierra Nevada. They work closely with land managers on specific issues: the California spotted owl; neotropical-migratory and resident birds; diurnal and nocturnal small mammals which are essential food to many species of concern such as spotted owls, pine martens, fishers, and other small forest carnivores; freshwater fish and amphibians associated with riparian and meadow habitats, and how management actions affect them. Scientists are also working on questions about forest processes including forest stand and standing dead tree dynamics. They are also working on several questions with other disciplines including the relations between fire and insects and standing dead tree processes.

Research Values Added:

- Increased knowledge on ecosystem linkages critical to sustaining viable populations of California spotted owls and the diversity of vertebrate communities.

- Better information on the responses of plant and animal communities to ecosystem management.

Forest Sciences Laboratory for Western Forest Ecology and Management

Four science teams located in Redding, Calif., are developing concepts, information and predictive models of the dynamic nature of Western forests. They are also working to determine effects of management strategies on forest productivity, health, and sustainability. This research, development, and application program is developing innovative research projects to improve understanding of how site characteristics, soil factors, and soil processes interact to control forest productivity. Researchers are dedicated to improving the scientific basis and understanding of how forest management practices affect composition, growth, and development of forest vegetation. A key linkage to improved forest management strategies is to investigate the effects of fires, insects, pathogens, and other disturbance factors on sustainability of forest ecosystems of northern California and the Sierra Nevada range. Finally, the Redding unit is developing analytical tools to integrate knowledge of forest ecosystems into effective forest management decisions.

Eastside pine types on Blacks Mountain Experimental Forest.

Research Values Added:

Soil and Site Productivity Science Team:

• Increased knowledge on how changes in site organic matter and soil porosity affect the physical, chemical and biological soil factors controlling site carrying capacity for net primary productivity.

• Information on the long-term ecological impacts of vegetation control on soil development and forest productivity.

• Knowledge of the biological potential of planted forests to capture carbon when not constrained by nutrition, insect pests, or competition from other vegetation.

Forest Growth and Development Science Team:

• Methods to maintain and enhance existing late successional stands and to accelerate stand structures in young forests to develop stands with characteristics of old-growth forests.

• Data on conifer, hardwood, shrub, forb, and grass density and development in different disturbance regimes.

• Models for growth and yield projection systems for forest tree species within the Sierra Nevada range and northern California.

Disturbance Factors Science Team:

• Information on the spatial relationships and changes in landscape patterns (patches, species composition, age classes, stand structure) as influenced by fire over the last 300 to 500 years.

• Information on disturbance factors and relationships, including the degree to which ecological functions of disturbances can or cannot be replaced by silvicultural practices.

• Methods to integrate dendrochronology and paleoecological techniques to provide detailed interpretation of long-term vegetation/fire dynamics.

Decision Support Systems Science Team:

• Geographical Information Systems (GIS)-based analysis tools to integrate the California Wildlife Habitat Relationships habitat suitability models for vertebrate wildlife species.

• Using fuzzy set mathematics in an analytical approach with spatial information to improve evaluation of landscapes as habitat for northern goshawk.

• Spatial analyses techniques to project locations of travel routes, archaeological sites and other spatial data for GIS decision support systems.

Forest Sciences Laboratory for Fire, Global Change and Recreation

Scientists at this PSW laboratory, located in Riverside, Calif., designed the "Fire Incident Command" strategy. This lab has five research units:

The Fire Meteorology Research group develops knowledge and tools for 1-10 day, monthly, and seasonal weather forecasts for fire management and climate change applications on national, regional, and local scales. These forecasts are essential for conducting prescribed burning, prepositioning of fire suppression resources, and providing efficient levels of suppression activity. The unit is leading the development of a prototype weather/wildfire modeling system for emergency management in partnership with universities, state and federal agencies, and the private sector.

Research Values Added:

- Provide improved forecasts saving millions of dollars in prescribed fire and wildfire suppression funding.

- Information integrating fire weather and climate models of different temporal and spatial scales.

- Information on the uncertainties in fire weather forecasts needed for fire planning.

Fire Management Research, Development, and Application devises methods to reduce the costs of fighting wildfires through the development of methods for escaped-fire situation analyses, severity funding analyses, and national fire management funding assessments. With fire suppression costs rapidly approaching one billion dollars a year, this research will provide fire managers with the tools they need to more efficiently use their funds and thus reduce overall costs.

Research Values Added:

- Providing the fire community with comprehensive strategic planning tools to construct quality protection programs that are cost efficient.

- Decision support systems that assure the most effective and efficient actions are taken in support of fire management operations.

Prescribed fire.

Prescribed Fire and Fire Effects Research scientists develop and provide scientific and technological knowledge that will improve land managers' capability to measure, model, predict, and mitigate the behavior and effects of prescribed fire, wildfire, and other disturbances on southwestern ecosystems. They produce management guides for fire prescriptions that meet resource objectives while utilizing weather and fuels information. These guides are necessary to combat the widespread buildup of forest fuels, and the associated increase in severe wildfires and decline in forest health that are pervasive throughout the West. They investigate the impacts of fire and other disturbances on erosion and vegetation recovery in chaparral steeplands and associated woodland ecosystems, helping land managers make cost-effective decisions about postfire mitigation.

Research Values Added:

- Information on how the important biotic and abiotic ecological processes function and interact in fire-dominated ecosystems.

- Understanding the effects of prescribed fire, wildfire, environmental stress, and other management treatments on ecosystem processes.

- Models and methodology to predict and monitor responses of fire-dominated, dry temperate, and dry tropical ecosystems to disturbances such as prescribed fire, wildfire, changing climate, and other management strategies.

- Understanding the important factors controlling wildfire and prescribed fire behavior in fire-dominated ecosystems.

Air Pollution and Global Change Impacts on Western Forest Ecosystems unit studies the effects of air pollution and climate change on both forest ecosystems and individual tree species in the western United States and proposes strategies for their mitigation. This research is essential in identifying forest

communities that are impacted by air pollution, and characterizing its impact on overall ecosystem health. Furthermore, the identification of mitigation measures is necessary if we are to maintain forests in these areas.

Research Values Added:

• Increased knowledge needed to assess the responses of western forest tree species, and community and ecosystem processes to air pollution and climatically-driven environmental stresses.

• Increased knowledge needed to assess biogeochemical responses of watersheds to disturbance from atmospheric deposition of pollutants, management practices, and climate changes.

Wildland Recreation and Urban Cultures conducts research that assists the development of effective visitor management strategies for high-use wildland recreation areas so that resources are protected while meeting recreationists needs. Results from this research focus on recreation patterns, including those derived from ethnicity and technological advances. Factors underlying conflicts and their resolution; values, attitudes, and behaviors related to natural resources; and visitor communication strategies are also studied.

Research Values Added:

• Provide information on changing recreation patterns that includes those derived from ethnicity and technological advances.

• Increased critical information on barriers and conflict in recreation participation and decision making.

• Increased knowledge about communication related to recreation and natural resource use.

• Provide additional information about values, attitudes, and behaviors related to natural resources.

Institute of Pacific Islands Forestry

Lab headquarters is Honolulu, with small field offices in Hilo and Volcano (Hawaii), Guam, and Yap (Federated States of Micronesia). The Institute's work is conducted by a unique structure of teams that include both scientists funded by Research and professionals funded through State & Private Forestry and International Forestry. The Institute has three multidisciplinary science teams.

The Restoration Team is determining how to put tropical forests back on lands that were cleared for agricultural use and, as a result, are unsustainable. Such forests have immense conservation and economic value. They serve as habitat for Hawaii's record-high numbers of threatened and endangered species as well as offering a mix of harvestable (e.g., wood, water, game animals) and non-consumable (e.g., ecotourism, recreation, aesthetic) products of great economic importance to the State.

Research Values Added:

• Understanding of the ecological structure and functioning of native forests on Pacific islands.

• Information on the ecological underpinnings of sustainability and restoration.

• Information and techniques to restore mixed-species forests, including those of economic importance.

The Forested Wetlands Team works on both mangrove forests and freshwater-forested wetlands on tropical islands throughout the Pacific. Its scientists are determining how soil environmental conditions and tree species composition are affected by harvesting, and how different management practices in these wetlands affect coastal lagoons and reefs. This research also explores impacts of invading mangrove trees on coastal resources in Hawaii.

Research Values Added:

• Understanding of the differences in environmental characteristics among riverine, fringe, and interior mangrove swamps and the suitability of different management practices in each.

• Information on the importance of freshwater forested wetlands to downstream coastal and marine ecosystems.

• Understanding the role of mangroves as invasive species in the Hawaiian Islands.

The Alien species Team is the core of the Institute's recent investments in new science, in response to national and statewide concern regarding the impact on non-indigenous species on native forests. Despite the tremendous attention devoted to alien species in Hawaii in the past few years, this is the only group dedicated explicitly to research on those invading plants, their impacts on native forests, and their control.

Research Values Added:

• Information on alien species to identify the processes involved in their invasions.

• Understanding of communities subject to invasions to determine why they are vulnerable.

• Increased knowledge on the impacts of invasions by alien species.

• Increased control measures, including biological control, for invasive alien weeds.

Science based products the Pacific Southwest Research Station develops and delivers help people make better-informed decisions, leading to more efficient and effective use and stewardship of natural resources.

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Ecosystem Management in the Bitterroots

by Lucia Solorzano and Jane Kapler Smith, Rocky Mountain Research Station

Big Sky Country doesn't get much better than the Bitterroot Valley in southwestern Montana. The Bitterroot National Forest encircles the communities on the valley floor with thousands of acres of wildlands to be hiked, fished, birded, used and enjoyed. But for conservationists, ecologists, and many long-time residents, this picture seems threatened. On acreage where old growth ponderosa pine once presided over open spaces, thickets of Douglas-fir and grand fir now block the sun. Newcomers living at the edge of the Forest learn that wildfires threaten their safety. Populations of migratory birds decline as the human population of the valley increases.

This is hardly the scenario envisioned a century ago by settlers in the Bitterroot Valley, but it is a reality that the Bitterroot Ecosystem Management Research Project, BEMRP, is working to understand and change. BEMRP began in 1993 as a five-year partnership between the Intermountain Research Station (now part of the Rocky Mountain Research Station, RMRS), the Bitterroot National Forest, the University of Montana, and the public. The Project has four objectives:

- predict how managing vegetation at the landscape level influences outputs and values in altered Rocky Mountain ecosystems;

- demonstrate how altered ecosystems can be rehabilitated;

- evaluate what resource outputs and values are important to the diverse public living in the area;

- develop concepts and tools to incorporate ecosystem-based principles into land management.

Though BEMRP's work focuses on the Bitterroot, the area serves as a microcosm for examining the full spectrum of forest health and resource management conflicts now widespread in the inland West. BEMRP studies initially focused on four divisions--vegetation, fauna, landscape, and human dimensions. As the knowledge base from the four research groups has grown, the focus has shifted. For BEMRP's annual workshop in April 1998, interdisciplinary teams are working with members of the public to integrate information on past and current conditions of ecosystems in the Bitterroot. Projects in riparian areas and upland ponderosa pine/ Douglas-fir demonstrate the breadth of information they are synthesizing.

Riparian Habitat

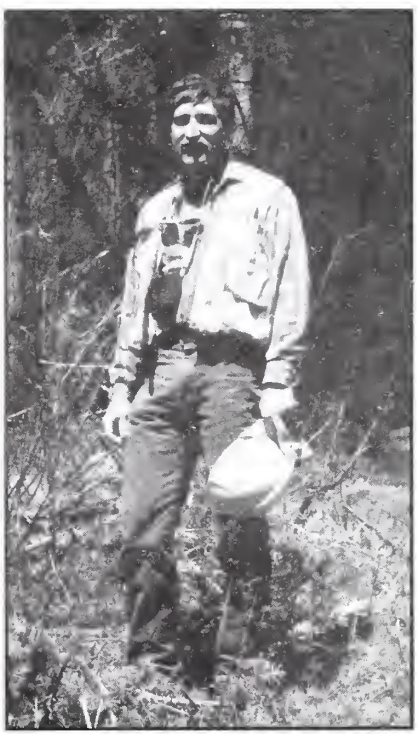
The rich riparian regions of the Bitterroot Valley--especially the narrow strips of land along forest streams--challenge specialists dealing with vegetation, wildlife, and modeling to work together. Thanks to several field trips during the past three years, members of the public have joined researchers to learn about current conditions and opportunities for restoration.

In 1995, visitors to the Larry Creek riparian site faced a virtual wall of young grand fir. This dense growth of conifers hid the fire-scarred stumps of large ponderosa pine and western larch harvested a century ago and obscured views of the few remaining mature pine, larch, and cottonwoods. A few shrubs persisted in the understory. Matt Arno, a University of Montana graduate student working with Research Forester Mick Harrington, RMRS, explained to visitors that, prior to 1900, frequent low-intensity fires allowed ancient pine and larch, both

Before harvesting, May 1995; can you find researcher Matt Arno next to the fire-scarred tree stump? (photo by Madelyn Kempf)

seral species, to dominate in open stands with an understory of deciduous shrubs. Harvesting of large trees and exclusion of fire caused the change to dense fir cover.

One year later, visitors to Larry Creek noted the first steps in an experimental restoration treatment--partial opening of the canopy and removal of understory thickets. Harvesting with low-impact equipment was completed on two feet of snowpack in winter 1996-97, and the site was prescribed burned in October 1997 by Bitterroot National Forest staff. Participants in a field trip planned for summer 1998 will seek the regeneration of deciduous shrubs and seral conifers that both researchers and managers hope for.



After harvesting, May 1996; Bitterroot National Forest Wildlife Biologist Dave Lockman looks for sprouting shrubs on treated riparian site. (photo by Jane Kapler Smith)

University of Montana graduate student Joshua Tewksbury, working with Wildlife Biologists L. Jack Lyon (retired) and Sallie Hejl, RMRS, is glad to see Arno's work to restore deciduous cover on riparian sites.

Tewksbury notes that more than 60 percent of the bird species that breed in the West do so primarily in riparian habitat. Though deciduous riparian sites account for less than five percent of the Bitterroot National Forest area, Tewksbury's research shows that 20 percent of all bird species detected in the Forest occur exclusively in this habitat. Furthermore, bird species richness is 44 percent greater in deciduous than coniferous riparian cover.

Parasitism of nests by Brown-headed Cowbirds increases the urgency of riparian site restoration in the Bitterroot ecosystem. Cowbirds lay their eggs in the nests of smaller birds. Cowbird nestlings are larger, noisier, and stronger than the nestlings of the host species and often out-compete the nesting birds' own young for food. Tewksbury's research shows that cowbird parasitism decreases with increasing distance from agricultural areas. Although most deciduous riparian areas within the Forest are small compared with riparian areas along the Bitterroot River, they may serve as refuges from cowbirds for species like the Dusky Flycatcher and American Redstart.

Healthy aquatic systems form the heart of high-quality riparian sites. University of Montana graduate student Sophie Osborn is studying the nesting patterns of a bird that signals habitat quality by its very presence--the American Dipper, also known as the water ouzel. The Dipper nests on streamside cliffs, by waterfalls, and sometimes on large boulders in mid-stream. It also nests under bridges in more developed areas, although on six of seven large creeks studied, Dippers were more likely to be present in undeveloped stream reaches. Says Osborn, "Dippers share many of the same habitat needs as native fishes. Their potential for indicating habitat quality may be an additional incentive to protect their environment."

Recent developments in computer modeling by Jimmie Chew, Forester, RMRS, have increased opportunities for managers to assess riparian systems. Chew has developed the SIMPPLLE computer model (SIMulating vegetative Patterns and Processes at Landscape scaLE), which enables planners to assess the potential for current forest health problems to worsen if left untreated. Initially, SIMPPLLE described vegetation based on stand boundaries, which identified few of the narrow riparian strips characteristic of mountain drainages. In fall 1997, a prototype model was unveiled that incorporated characteristics of map images to represent existing aquatic units, aquatic processes, and potential aquatic sites. Now, Chew explains, "We can represent the aquatic component, we can capture our knowledge of its dynamics,

and we can model its interactions with the vegetative component as it changes within a landscape." Restoration of historic vegetative patterns would be a positive change for the willows, alders, warblers, and Dippers that depend on healthy riparian areas.

Upland Ponderosa Pine/Douglas-fir

Three field trips in the past year have taken BEMRP researchers, managers, and the public to upland ponderosa pine/Douglas-fir forests. Like riparian sites, forests with ponderosa pine and Douglas-fir cover have been altered in the past century by fire exclusion and selective logging of large seral species. Unlike riparian habitat, however, ponderosa pine/Douglas-fir covers a large proportion of the landscape on the Bitterroot and throughout the inland West. This forest type covers nearly half of the non-wilderness land in the Bitterroot National Forest. What are some of the consequences of a century of change?

Steve Slaughter (center, Lolo National Forest) describes treatments in upland ponderosa pine/Douglas-fir during a May 1997 field trip. (photo by Jane Kapler Smith)

- Increased risk of severe fire and continued loss of large, old ponderosa pine, answers Research Forester Steve Arno, RMRS.

- Increased infestation by Douglas-fir dwarf mistletoe and *Armillaria* root disease, adds Clint Carlson, RMRS Program Leader (retired).

- Decreased forage and increased cover for large ungulates, responds Wildlife Biologist L. Jack Lyon, RMRS (retired).

- Decreased nesting habitat for large cavity nesters like the Pileated Woodpecker and Flammulated Owl, answer Wildlife Biologists Sallie Hejl and Vita Wright, RMRS.

- Long-term alteration of habitat from historic conditions, perhaps toward a state that cannot support species present in the past, worries District Ranger Tom Wagner, Bitterroot National Forest.

Ecological questions alone are complex in the ponderosa pine/Douglas-fir cover type, but they are given greater urgency by proximity to thousands of new homes now located in this wildland forest type. Ponderosa pine/Douglas-fir forest dominates the wildland/urban interface in the Bitterroot and throughout the inland West. How can it be managed, especially in the face of shrinking Forest Service budgets?

Considerable help with this question comes from modelers and economists. The SIMPPLLE and MAGIS (Multi-resource Analysis and Geographic Information System) models developed by Jimmie Chew and Greg Jones, Research Forester, RMRS, provided information used by the Stevensville Ranger District's Interdisciplinary Team to assess conditions for the Stevensville West Central planning area. This area comprises 39,400 acres of the Bitterroot National Forest, in which upland ponderosa pine/ Douglas-fir is an important component. According to Dave Silvieus, Interdisciplinary Team Leader, SIMPPLLE "indicated that we really needed to take some action to prevent stand-replacing fires. Additional thinning and burning would be needed, over a longer period of time, to restore the landscape to a sustainable condition." MAGIS applies optimization routines to geographic information systems; use of this model enabled the Interdisciplinary Team to evaluate how combinations of proposed treatments could be used to meet watershed, wildlife, and economic objectives.

Restoration treatments like those planned for the Stevensville West Central area can pay for themselves. University of Montana researchers Carl Fiedler and Charles E. Keegan have analyzed the economics of restoration in two stand types typical of upland ponderosa pine/Douglas-fir: a dense, second-growth pine/fir type, and a mature pine/fir type dominated by large ponderosa pine and mistletoe-infested Douglas-fir. Restoration prescriptions for these two stand types were developed solely to address ecological problems and imbalances in density, structure, and species composition, but the prescriptions generated timber products with substantial economic value. Trees cut under the restoration prescription in the second-growth stand type would generate a net revenue of about $500/ha, even without a pulpwood market. Implementing the restoration prescription in the mature type with numerous large Douglas-fir would yield a net value of approximately $4,500/ha. Although product values were somewhat lower on steeper ground that would require cable yarding systems, net revenues were still positive for both stand types.

As research results are applied to projects on the Forest, BEMRP participants continue to analyze the complexities of ponderosa pine/Douglas-fir forests and the landscapes in which they occur. Projects include an assessment of restoration treatment effects on soils, an investigation of the longevity of fire-created snags, and several studies on detection of wildlife species.

Valley Bottom to Mountain Top

Research and demonstration projects in other parts of the Bitterroot ecosystem reinforce the importance of proactive treatments for the land. Treatments are completed or underway in high-elevation whitebark pine forests severely threatened by white pine blister rust, mid-elevation lodgepole pine forests where community-level diversity is decreasing, and native fescue grasslands on the valley bottom that have been invaded by exotic weeds.

Since any restoration project large enough to make an ecological difference at a landscape scale requires participation by community members, BEMRP has sponsored frequent communications programs (field trips, workshops, written reports, and an Internet site) and extensive public involvement on a District-level project. Kathleen Guthrie, University of Montana graduate, interviewed participants in the public involvement program to describe the many ways in which managers, researchers, and members of the public define success in public involvement. Success is not measured simply by the number of public meetings or absence of an appeal, Guthrie reports, but also by measures such as mutual learning, a sense of ownership, building relationships, and breadth of public involvement. Sociology Professor Rebecca Richards, University of Montana, has assessed the potential for using various collaborative approaches for public involvement in Forest Plan revision. Currently existing collaborative groups can contribute a great deal to Forest planning, Richards reports, but "that route must be expanded through personal interaction, localized by holding open community meetings, and given meaning through common and concrete, achievable goals. Most importantly, both the public and the agency need to recognize the limitations of the public participation process." Continued discussion is essential for limitations to be understood and accepted.

Prescribed fire torches a subalpine fir in whitebark pine stand on the Bitterroot National Forest (photo by Steve Arno).

BEMRP participants will use the coming year to continue synthesizing research results and to dialogue with Bitterroot community groups, seeking opportunities for restoration of altered ecosystems. They will address the riparian and ponderosa pine/Douglas-fir communities described here as well as other portions of the ecosystem, and present findings at the Project symposium in May 1999.

Rocky Mountain Research Station projects and programs Participating in the Bitterroot Ecosystem Management Research Project	
Research Project	**Leader**
Fire Effects (4403)	Kevin C. Ryan
Forest Ecology and Management (4151)	Ward W. McCaughey
Economic Aspects of Ecosystem Management on Forest Lands (4802)	Ervin G. Schuster
Natural Areas Program	Angela G. Evenden
Wilderness Research Management (4901)	David J. Parsons
Wildlife Habitats (4201)	Len Ruggiero

"Ultimately questions concerning management must be resolved collaboratively by people willing to do the hard work of integrating concepts, evaluating model results, and weighing the interplay among resource values," observed Clint Carlson, retired Project Leader, in June 1996. The Bitterroot Ecosystem Management Research Project is approaching the end of its initial five-year charter, but Program Leader Greg Jones hopes that the impact of this "hard work"--and its continuation--will stretch far beyond the borders of the Bitterroot and the end of this century.

For more information about the Bitterroot Ecosystem Management Research Project, contact Jane Kapler Smith (e-mail jsmith/rmrs_missoula@fs.fed.us, phone 406-329-4805) or visit the BEMRP Web site. You can visit the site through the Rocky Mountain Research Station's Web page, www.xmission.com:80/~rmrs (link to "Other RMRS sites...") or go directly to www.forestry.umt.edu/bemrp.

INT and RMRS Publications Describing BEMRP Research

Arno, Stephen F.; Scott, Joe H.; Hartwell, Michael G. 1995. *Age-Class Structure of Old-Growth Ponderosa Pine/ Douglas-fir Stands and Its Relationship to Fire History.* Research Paper INT-481. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 25 p.

Carlson, Clinton E.; Floch, Rick F. 1996. *Lick Creek Ecosystem Management/ Research Demonstration Area.* In: Schmidt, Wyman C.; Friede, Judy L., compilers. *Experimental Forests, Ranges, and Watersheds in the Northern Rocky Mountains: A Compendium of Outdoor Laboratories in Utah, Idaho, and Montana.* General Technical Report INT-334. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 81-86.

Fiedler, Carl E.; Keegan, Charles E.; Arno, Stephen F. 1997. *Utilization as a Component of Restoring Ecological Processes in Ponderosa Pine Forests.* In: Barbour, R. James; Skog, Kenneth E., editors. *Role of Wood Production in Ecosystem Management: Proceedings of the Sustainable Forestry Working Group at the IUFRO All Division 5 Conference, Pullman, Washington, July 1997.* General Technical Report FPL-100. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 24-28.

Hardy, Colin C.; Arno, Stephen F., eds. 1996. *The Use of Fire in Forest Restoration.* General Technical Report INT-341. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 86 p.

Zuuring, H.R.; Wood, W.L.; Jones, J.G. 1995. *Overview of MAGIS: A Multi-Resource Analysis and Geographic Information System.* Research Note INT-427. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 6 p.

Lessons From a Flooded Landscape

by Sally Duncan for
Pacific Northwest
Research Station

On the soggy morning of February 6, 1996, Gordon Grant, a fluvial geomorphologist at the Corvallis Lab, logged on to the Internet to check the gauging stations in and around the H.J. Andrews Experimental Forest, 100 miles southeast. When he saw that the McKenzie River was going up 1,000 cubic feet per second every hour, he knew some serious chaos was at hand.

Grant and Fred Swanson, a Forest Service geologist and Andrews Forest project leader, headed immediately for the mountain forest. After all, the last major flood event, in 1964, had predated both their research careers.

Both reacted viscerally to the scene of the flood, once they were literally standing in it. "There is a dramatic power to such a huge landscape event, a feel, a smell to it," Grant says. "It was absolutely the high point of my career, the field experience you dream about."

The 1996 flood crystallized scientists' thinking about flood effects and dynamics.

Swanson vividly describes the kahwoomp sound of giant boulders rumbling along the streambed, and the "Rip City!" experience of watching whole old-growth trees, with root wads intact, racing down river channels. He recalls standing beside a flooded main channel watching the rapid approach, trunk first, of an old-growth tree captured by floodwaters. "The tip of the trunk lodged in the bank right at my feet. Then the force of the current took the root wad and swung it around to lead downstream. The current yanked the tree top out of the bank, and on it went."

"This is when the physical work of the landscape gets done," says Grant. "More sediment and debris of every kind, from the boulders and the trees to the finest silt, entered the main streams in those 24 hours than will in probably the next 40 or the previous 30 years." And thus more dramatic change was wrought upon the landscape than will occur again until the next "big one,"

"One thing the '96 flood has really emphasized," says Swanson, "is the tremendous value of Forest Service watershed research in hanging together through all the decades of boredom. It's a tricky balance between a maniacal persistence in collecting baseline data while very little seems to be happening, and yet responding to the current fashions in science or the latest management-policy issue." It is precisely those boring baseline data, decades' worth of them, that let researchers truly "measure" the events of the flood. Their patterns through the decades provide a context for understanding major flood events.

Legacy of Knowledge Builds From the Flood of '96

Rather than dramatically changing existing ideas about flood effects and dynamics, the '96 flood seems to have crystallized many of the hypotheses, according to Swanson. Perhaps its most valuable legacy has been to encourage new ways of thinking.

First, in the natural forest, floods are not just about a lot of water. During a flood, uncountable diverse processes are happening in stream channels and on hillslopes. Many of them connected. On the hillslopes there are landslides, debris flows, quantities of snow absorbing water or melting at various rates, and interactions between the stream and the road system. In the channels there is rising water, moving wood, sediment input ranging in size from silt through gravel to boulders. Everywhere, the transfer of potential to kinetic energy.

The linking of all these processes creates what researchers call a disturbance cascade: some cascades have a snowball effect and get larger as they go, others act more like an unrolling rug, and dissipate their energy and effects quite rapidly. For example, the making of a debris flow starts with saturated soils that begin to liquefy. Some flows never make it into the first small channel, hung up by an old-growth tree, a lack of content, a failure to attract a following. The rug is unrolled, the energy spent.

But if they do gather enough mass, they'll start taking out streamside shrubs and logs, increasing momentum and power on their way to the main channel. By this time, they're big enough to take on large stands of alder, shift boulders the size of Volkswagen bugs, add their weight to the force of the flow through the channel. The snowball effect. With sufficient force, and speeds of 20 to 30 miles per hour, even remnant stands of old growth along the channel cannot always withstand the impact of such a channelized mass. The flood is intractably at work.

Comparing Responses to Two Floods

Land management activities do affect how a flood plays out across the landscape, in a sense because they intensify natural instabilities in the system. As the two activities with the greatest impact on the landscape, logging and road building come under particularly close scrutiny. Both affect the quantity of woody debris in small channels, the frequency of mass movements from hillslopes, and the interaction between streams and roads or bridges.

How do we accurately track the effects of management? By comparisons over time. Witness the differences between the '64 and the '96 floods. Grant and Swanson and their research teams have been able to compare the two in detail, both because of the Andrews flood research from '64, and all that boring baseline data in between.

Floods do the physical work of the landscape.

"In 1964, there had been 15 years of fairly constant logging, the road system had been built into the watershed from lower elevations, on the flood plains and midslope," explains Swanson, "and its objective was to move logs efficiently, not to consider landscape effects." Furthermore, there had been no big flood events in the previous 20 years to thoroughly "clean" the system, thus leaving a lot of big trees and logging debris to work major change in the stream system.

But by 1996, there had been 25 years without much logging or road construction, and that big flood just 32 years before. Specifically, in 1964 as much as 15 percent of the basin area had clearcuts younger than 15 years, and about 80 kilometers of roads the same age, whereas in 1996 there were only 2 percent of the clearcuts and less than 20 kilometers of roads less than 15 years old.

"Younger plantations are thought to have a higher susceptibility to sliding because of reduced root strength and possible effects on soil-water movement," says Swanson, so slide numbers from plantations were lower in the '96 flood. In addition, road-building methods had been modified substantially because of lessons from the '64 flood; road-related slides were reduced by about half in 1996. There was simply less large woody debris and fewer unstable slopes and roads to contribute to massive structural change.

Another player that differs between flood scenes is snow pack. The timescale of snow pack registers in days and weeks, rather than years and decades like landslides. By affecting the timing and height of peak flows, the amount of water stored in the snow pack can significantly exacerbate or diminish flood effects. The February 1996 flood came on the heels of high snowfall, as much as 112 percent of average. As the flood progressed, three zones of snow effect were apparent: a lower zone from 400 meters to 800 meters elevation where melting from a thin, wet snow cover added its volume to high rainfall; a middle zone from 800 meters to 1200 meters where a deeper snow pack first stored then released water; and an upper zone above 1200 meters where a very deep pack stored much of the precipitation and buffered the intensity of the storm in the upper elevations.

Integration is the New Wave of Science

Any flood leaves behind lasting teaching materials. But the lessons from this flood have a significant new aspect to them: integration. "In studies of the '64 flood, the focus was mostly on a limited set of questions in smaller watersheds, but we're now looking at larger basins, and how material is routed through the whole system," Swanson explains. There is less focus on just counting landslides, counting road failures, inventorying channel change. Instead, the emphasis is on "How do these pieces connect and so what?" And it ain't easy.

"We still fall into the trap of having some people look just at a horizontal view of the landscape via roads, and the people right beside them taking just the vertical view via landslides." In fact, as Grant says, "When you try to build an integrated study so that you can understand floods as systems, the connectivity of all these events becomes a kind of tyranny. Far from the old days when we dealt separately with roads, channels, slides, water, wood, we now get it that the flood doesn't care. It moves through a whole landscape, so if we want to understand it, we'd better have a good grasp of the whole landscape. And that takes a huge effort."

Biological Dynamics of Floods

Generalities first. "We need to remember these are dynamic systems whether we cut trees or build roads or not," says Swanson. "We've uncovered countless ways in which ecosystems are attuned to floods and their effects." He refers to the flood-pulse concept as an example. The idea is that land-based inputs pulsed into a river during a flood may actually improve the productivity of the river in terms of vegetation, fisheries, and wildlife.

What was the biological story in the flood? "Survival of species is a direct function of whether and where they can hide, such as relatively undisturbed side channels and flood plains, and an organism's ability to get to the refuges," says Swanson. Flood responses of cutthroat trout, sculpins and Pacific giant salamanders, the most abundant vertebrates in Andrews streams, tell the story. Trout are strong swimmers capable of moving quickly in the stream, even at high velocity, and take cover along edges or in woody debris during high flows. Sculpins move with considerably less speed and agility, and move into the streambed during high winter flows. Pacific giant salamanders are also bottom dwellers, move mostly by crawling, and are not strong swimmers.

"Trout survival was very similar to winters without major floods," Swanson says. "But sculpin and salamander were hammered hard, declining by about 65 percent. When flood discharge is sufficient to cause movement of gravel and boulders along the streambed, organisms limited to that habitat may be killed by moving particles." Grant adds, "The consequences of floods are not easily summarized as good or bad for humans or organisms. Much depends on the life cycles and strategies of the various critters."

Most management questions, then, need to be framed openly. What might help or harm particular species? How did the wild system work, and how did the management overlay affect it?

Road Building and Logging

Aspects of the road story were already known in sketchy fashion: ridgetop, midslope, and valley floor roads have different impacts on the landscape under flood conditions. Roads can fail in various ways. Roads in different landscape positions have different capacities to become a sediment source or a sediment sink.

The '96 flood brought roads under the research spotlight as landscape elements with distinct characteristics, rather than individual "case studies" of failure. It also provided more numbers to solidify the story. But what really came clear about roads was how to ask better questions.

Swanson takes some stabs. "How can we reconfigure roads to do tomorrow's job, not yesterday's? Now that road maintenance budgets are severely reduced because of less logging, how can we get roads to take better care of themselves?"

Likewise, logging practices are key players in flood times, and the details of their effects are coming to be better understood through the combination of flood data, baseline data, and integrated research. It does appear that younger plantations play a larger role than established stands in landslide activity during floods. The question becomes a complex study of ecological effects playing out beside risk and hazard management.

Each flood sees a different landscape. Where the 1964 flood knocked down old growth, it paved the way for subsequent older stands to fall in 1996.

"While no models are perfect, results from flood studies can contribute directly to our mapping of high hazard areas aimed at reducing risks to public safety," Grant says. Swanson, too, feels that while they cannot claim complete accuracy on causes and effects of each slide, existing data can offer extremely useful predictions of high hazard sites.

"What we have going in management," Grant concludes, "is a grand experiment with no possibility of replication. Surely we are required therefore to learn from events like floods that are episodic. Most importantly, we need to take some Zen moments, learnable moments, before we rush back in to 'restore' things. Our actions have consequences in time as well as space."

Sally Duncan is a science communications planner and writer specializing in forest resource issues. She lives in Corvallis, Oregon.

Scientists Profiles

Fred Swanson, a research geologist with the PNW Research Station, has been studying landslides and other erosion processes in western Oregon for more than 25 years. Swanson is also a leader of the National Science Foundation sponsored Long-Term Ecological Research program at the H.J. Andrews Experimental Forest. He is also leader of the Cascade Center of Ecosystem Management, a research-management partnership involving Forest Service Research, the Willamette National Forest, and Oregon State University.

Gordon Grant, a research hydrologist with the PNW Research Station, has been studying rivers for more than 15 years. Before that, his interest in fluvial processes was sparked by a decade-long career as a whitewater river guide. His research now focuses on the structure and behavior of mountain streams, and the effects of forest land use, dams, floods, and other disturbances on rivers and watersheds in the Pacific Northwest and elsewhere. He is also a courtesy associate professor of geosciences at Oregon State University.

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Fire Nourishes Biological Diversity in the Northern Great Plains

by Carolyn Hull Sieg and Rick Fletcher, Rocky Mountain Research Station

The Northern Great Plains region, stretching from Nebraska north through the Dakotas and into Manitoba, Saskatchewan and Alberta, Canada, is paved by seemingly endless expanses of grassland. The midsection of the region, dominated by mixed-grass prairie, is bordered by tallgrass prairie on the eastern edge. This sea of grass is broken by the forests of the Black Hills, and woody vegetation in draws, riparian areas, and on north-facing slopes. These are dynamic ecosystems, shaped by successional processes and abiotic disturbances such as fire, drought, and wind. The importance of disturbances in shaping these native plant communities is receiving increased attention by resource managers.

Mixed-grass prairie and Rocky Mountain juniper woodlands, Badlands National Park, SD.

Carolyn Hull Sieg, Research Wildlife Biologist at the Rocky Mountain Research Station's Laboratory in Rapid City, SD, is one of several Forest Service scientists and other natural resources specialists seeking a better understanding of the impacts of disturbances on the Northern Great Plains, specifically fire and its potential for maintaining and improving these ecosystems.

"An understanding of the frequency, timing, and intensities of past fires is necessary before fire can be incorporated into a strategy to conserve prairie systems," says Sieg. Historically, prairie fires were started by lightning and American Indians. Lightning was, and continues to be, an important ignition source in the Northern Great Plains. Historical accounts written between 1673 and 1920 reveal that fires accidentally or intentionally set by American Indians were common in the region. Fires were set to attract and herd wild animals, signal threats and warnings, improve pasture, mask and eliminate signs of campgrounds or trail use, and for pleasure, warfare, and ceremonies.

Using historical records and tree scar measurements, Sieg and other researchers estimate that fires occurred as often as every 1 to 5 years in the more mesic portions of the region, but less frequently in areas of rough topography and in lowlands. Lightning-caused fires occurred more often in July and August. American Indians set fires in nearly every month of the year; however, the greatest number were set in April, September, and October.

Developing a Fire Management Strategy

Researchers believe that the fire strategy most likely to manage diversity in the Northern Great Plains is based on two premises:

1) processes that mimic, as much as possible, the variability found in native ecosystems should be present and functioning; and

2) management activities should conserve or restore historical disturbance patterns.

"This strategy should reflect the differing roles that fire historically played in the various portions of the region," says Sieg. "However, this strategy must also address the fundamental changes that have occurred in the landscape, such as drastically different landscape patterns imposed by species changes and management unit boundaries."

One approach suggested for the Northern Great Plains is a scenario that mimics the presettlement fire history, including some high intensity summer fires on a return interval of 5 to 30 years. Shifting burning programs from all spring or fall burns to include some midsummer burns can favor some plant species not enhanced by spring or fall burns. For example, an April fire burns early foliage critical for root production of cool-season plants, leaving late-season plants unscathed; an August fire burns the largely inactive foliage of cool-season species, while consuming foliage and reproductive stems of warm-season species. Given the highly variable fire regime in the past, Sieg believes that burns of varying intensities at differing seasons are appropriate. Studies show that the interval between fires should be varied to best restore fire disturbance patterns of the Northern Great Plains. The strategy should avoid a uniformity in timing of burns or in intervals between burns that artificially simplifies what was probably a more complex system.

Biological Diversity

Reinstituting a fire regime based on historical processes that includes burning at varying intervals and in differing seasons is the first step in developing a strategy for using fire to manage biological diversity on native rangelands in this region. The second step involves assessing the direct and indirect impacts of fire on special habitats and sensitive plant species. "Special habitats are native biological communities or ecosystems that are rare, unique, or highly productive elements of regional landscapes," says Sieg.

This series of before, during and after photographs shows a controlled burn of crested wheatgrass (a planted, exotic species) conducted in the Badlands National Park, SD, to restore mixed-grass prairie.

"Sensitive species include those native species currently in danger of extinction or those whose population trends are negatively affected by human actions." The special habitats of the Northern Great Plains (wetlands, lowlands, and riparian areas) contain high numbers of listed vulnerable species. Sieg stresses that if sensitive communities such as these occur within a management unit, burning programs should be examined relative to the impacts on these habitats.

Wetlands, lowlands, and riparian woodlands in this region are examples of communities that, because of higher moisture, likely burned less frequently than uplands. However, the narrow configuration and close contact of these woodlands with flammable grassland fuels suggest that, historically, they were exposed to a high number of grassland fires. Earlier research found that, since the species composition in woody draws includes a number of deciduous species, and that several woody species establish best in mineral soils, fire probably functioned as a regeneration mechanism in these systems. Further, since these communities stay green longer than uplands, fires probably burned late in the growing season when there were adequate levels of cured, fine fuels. Repeated, annual fires, especially during droughts, tend to favor the growth of grasses over woody plants. Fires occurring infrequently when plants are dormant, followed by high precipitation, may enhance woody plant growth. "If the goal is to regenerate woody plants in woody draws, and/or to mimic historical fires, prescriptions should be set to achieve high intensities," says Sieg.

Threatened and Endangered Species

Threatened or endangered plant species are examples of sensitive species whose needs cannot be ignored. Because they are the first species to drop out of ecosystems, they are considered the weakest link in the conservation of native biological diversity. Vegetation management can be a useful tool for maintaining and restoring biodiversity, and for delisting or avoiding listing of certain species. Sieg says that adjusting fire management programs to meet the needs of threatened and endangered species requires an understanding of the role of fire in the long-term sustainability of the ecosystems supporting these species, and in the life history and habitat needs of individual species.

One study Sieg is leading involves the federally listed threatened western prairie fringed orchid (Plantanthera praeclara) which grows in tallgrass prairie. Although the tallgrass prairie is prone to burn every 1 to 5 years, it is unlikely that the low-lying wet land where the orchid grows burns as often, especially during wet years. "Lowlands supporting orchid populations likely burned throughout the growing season during prolonged droughts," says Sieg, "however, we found that fires that occur when orchids are actively growing are apt to injure or kill the plants. Since

fall burning allows orchids to complete their life cycle, and dry conditions and lightning are inclined to occur late in the growing season, we found that fall fires are a better choice than spring burning to sustain orchid populations and their associated habitat."

Introduced Species

The introduction of exotic species to new environments without their associated parasites and pests is a concern to resource specialists in the Northern Great Plains. Many introduced invasive species have characteristics that enable them to vigorously compete with native plants and to exploit disturbed areas. Although fire is not a panacea for discouraging introduced species, with careful planning, scientists believe it can be a useful tool. Past studies show that burning at a time when plants are most vulnerable is useful for suppressing undesirable species. Sieg points out a Nebraska study where burning in mid or late May, when smooth brome tillers are either elongating or

Western prairie fringed orchid (photo by Carolyn Hull Sieg).

heading, reduced tiller density of smooth brome by 50 percent when compared to unburned plots. However, scientists point out that burning is not a cure-all for reducing persistent species. In fact, it may even contribute to the expansion of some species such as Canada thistle. The outcome is also dependent on other factors such as climate and precipitation patterns.

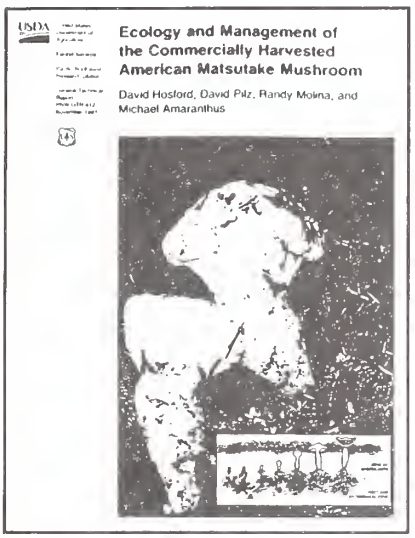
One study by scientists at the Rapid City lab shows that, in addition to killing or injuring exotic plants, burning can be used to make the habitat less conducive to species expansion. Spring burning in western South Dakota killed Japanese brome seedlings for one growing season, and by reducing litter accumulations, decreased future germination rates. The key to success in managing invasive species is to begin treatment before expansive spread occurs and to focus as much as possible on the invaded ecosystem rather than on the invader.

Additional information about this research and related studies is available in the paper, *The Role of Fire in Managing for Biological Diversity on Native Rangelands of the Northern Great Plains*, by Carolyn Hull Sieg. The paper is contained in, *Conserving Biodiversity on Native Rangelands: Symposium Proceedings*, General Technical Report RM-298, available from the Rocky Mountain Research Station. You can contact Carolyn Hull Sieg by writing to her at:

Rocky Mountain Research Station, Forestry Sciences Laboratory, 501 East St. Joseph, Rapid City, SD 57701.

New From Research

Ecology and Management of the American Matsutake Mushroom



The commercial harvest of American matsutake from forests in the Pacific Northwest has increased dramatically. This summary paper begins by reviewing the historical importance of the Japanese matsutake, its declining production and harvest in Japan, the taxonomy of matsutake species worldwide, ecological research pioneered by the Japanese, and how Japanese forests are managed for matsutake production. The paper also examines current matsutake research and monitoring activities in the Pacific Northwest and explains the relevance of these activities for integrating the harvest of the American matsutake into forest ecosystem management plans.

Request *Ecology and Management of the Commercially Harvested American Matsutake*, General Technical Report PNW-412, from the Pacific Northwest Research Station. Supplies are limited.

Trouble from the Brown-Headed Cowbird

The numbers of brown-headed cowbirds (*Molothrus ater*) are increasing in some regions of North America. At the same time, certain populations of long-distance, neotropical migratory songbirds (NTMs) are declining. Scientists believe that the decline of two species of NTMs, the southwestern willow flycatcher and the least Bell's vireo, may be due primarily to broad parasitism by the brown-headed cowbird. Researchers collected and reviewed existing data on the cowbird in New Mexico, compared them to data from adjacent western states, and interpreted the findings.

The authors hypothesize that increased human use of riparian habitats in New Mexico result in increased abundance of brown-headed cowbirds and their parasitism on riparian-dependent NTMs. They suggest more studies are necessary to formulate conclusions about the multiplicative effects of riparian habitat use and modification by human activities on cowbird and rare NTM populations. Results of these studies are published in, *The Brown-Headed Cowbird and Its Riparian-Dependent Hosts in New Mexico*, General Technical Report RMRS-1, available from the Rocky Mountain Station while supplies last.

Mechanical and Chemical Release in a 12-Year-Old Ponderosa Pine Plantation

Among methods tested to increase the survival and growth of planted ponderosa pine seedlings, mechanically cutting shrubs and applying herbicide were the most cost-effective treatment. These are the findings of two scientists at the Pacific Southwest Research Station, Gary O. Fiddler and Philip M. McDonald.

A 12-year-old ponderosa pine plantation on the Tahoe National Forest, in northern California, underwent two treatments. In one, wood shrubs were cut with a Hydro-Ax, which resembles a rotary lawnmower. In the other, mechanical release was combined with chemical application. The results were compared with an untreated control plot.

After 11 growing seasons, crown cover, height, and diameter had increased in the plantation treated by Hydro-Ax and herbicide; mean crown cover was 104 percent greater, height was 45 percent greater, and diameter was 47 percent greater. Relative costs were $225 per acre for the Hydro-Ax alone (mechanical) and $273 per acre for the Hydro-Ax plus herbicide (chemical), making chemical treatment the most cost-effective.

Request *Mechanical and Chemical Release in a 12-Year-Old Ponderosa Pine Plantation*, Research Paper PSW-232, from the Pacific Southwest Research Station (at its distribution center in Fort Collins, Colorado). Supplies are limited.

Vegetation at Glacier Lakes

The Glacier Lakes Ecosystem Experiments Site (GLEES) was established in the Snowy Range of the Medicine Bow Mountains of Wyoming to study the effects of air pollution on the structure and function of subalpine and alpine ecosystems. Research at the site uses an integrated ecosystem approach to assess the environmental impacts of human-induced atmospheric deposition and climate change in a landscape typical of high elevation wilderness systems. These assessments require baseline data to quantify the current environmental and biological status of the ecosystem and to study each biological and physical component.

To help develop a baseline for intensive studies of ecosystem processes at GLEES, scientists have documented 304 vascular plant taxa of the entire area and categorized and described the vegetation types based on quantitative data. They identified in detail 4 meadow, 4 thicket or scrub, 3 krummholz, and 2 forest plant associations. The report describing this documentation is available from the Rocky Mountain Research Station while supplies last. Request *Vegetation of the Glacier Lakes Ecosystem Experiments Site*, Research Paper RMRS-1.

below. All cards require postage. Please remember to use your Zip Code on the return address.

Please send the following Pacific Northwest Station publications:
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1) *Ecology and Management of the Commercially Harvested American Matsutake,* General Technical Report PNW-412.

2) *Evaluation of the Use of Scientific Information in Developing the 1997 Forest Plan for the Tongass National Forest,* General Technical Report PNW-415.

3) Other_____

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1) *Conserving Biodiversity on Native Rangelands: Symposium Proceedings,* General Technical Report RM-298.

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2) *Experimental Forests, Ranges, and Watersheds in the Northern Rocky Mountains: A Compendium of Outdoor Laboratories in Utah, Idaho, and Montana,* General Technical Report INT-334.

3) *The Use of Fire in Forest Restoration,* General Technical Report INT-341.

4) *Overview of MAGIS: A Multi-Resource Analysis and Geographic Information System,* Research Note INT-427.

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1) *Metasystox-R Applied in Mauget Injectors, Ineffective in Protecting Individual Ponderosa Pines from Western Pine Beetles,* Research Note PSW-420.

2) *Mechanical and Chemical Release in a 12-Year-Old Ponderosa Pine Plantation,* Research Paper PSW-232.

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Metasystox-R Ineffective in Ponderosa Pines

The insecticide Metasystox-R, applied in Mauget tree injectors, was found to be ineffective in protecting individual ponderosa pines from western pine beetles on the Eldorado National Forest in central California, on the western slope of the Sierra Nevada. Researchers Michael I. Haverty, Patrick J. Shea, and John M. Wenz considered the treatment ineffective if an average of less than 90 percent of the treated trees survived.

The effectiveness of registered application rates of Metasystox-R applied with Mauget injectors was assessed as (1) a preventative treatment (before attack by western pine beetles, and (2) a remedial treatment (after attack by western pine beetles). Both treatments failed to meet the criterion of efficacy. Therefore, these treatments will not provide forest pest control specialists, land managers, or private citizens with an effective alternative to insecticides such as lindane and carbaryl applied to the bole of trees as toxic sprays for protection of high-value ponderosa pine from attack by the western pine beetle.

Request *Metasystox-R, Applied in Mauget Injectors, Ineffective in Protecting Individual Ponderosa Pines from Western Pine Beetles*, Research Note PSW-420, from the Pacific Southwest Research Station (at its distribution center in Fort Collins, Colorado). Supplies are limited. This publication is also available on PSW's home page at: http://www.psw.fs.fed.us.

Scientific Information in the Development of the Tongass National Forest Plan

The authors of this technical report participated as scientists on the Tongass Land Management Planning Team from 1995 to 1997. This paper explores how scientific information was used in making management decisions, and evaluates whether the decisions were consistent with the available information. This paper does not consider any information gathered after the signing of the record of decision on May 23, 1997, or deal with subsequent implementation of the 1997 Tongass Forest plan.

Request *Evaluation of the Use of Scientific Information in Developing the 1997 Forest Plan for the Tongass National Forest*, General Technical Report PNW-415, available from the Pacific Northwest Station while supplies last.

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